Technical Memorandum

To:	Javier Toro Rosemont Copper Company Tucson, Arizona	**Project No:** 1720214024	
By:	Jared Mullenbach Wood Environment & Infrastructure Solutions, Inc. (Wood)	**Reviewed by:** Peter Yuan, PE. PhD	
Tel:	775-398-7188	**CC:** File	
Date:	February 2, 2022		
Re:	**Heap Leach Pad (HLP) Pipe Settlement Analysis Rosemont Copper World Project**		

1.0 Purpose

This Technical Memorandum presents estimates for potential heap leach pad (HLP) settlement after proposed grading and loading and an evaluation of potential effect on the performance of planned HLP drainage systems from estimated settlements. Wood Environment & Infrastructure Solutions, Inc. (Wood) prepared this evaluation for Rosemont Copper Company's (Rosemont's) Rosemont Copper World Project (Project) to support the Aquifer Protection Plan (APP) application in accordance with the Best Available Demonstrated Control Technology (BADCT) Manual (Arizona Department of Environmental Quality (ADEQ), 2004). The BADCT document specifies that settlement of the HLP foundation be considered in design, and the purpose of this report is to demonstrate that foundation settlement will not significantly affect the drainage performance or cause adverse flow along the HLP primary solution collection system (System).

2.0 BADCT Criteria

The use of BADCT to minimize the impacts to groundwater is required by ADEQ to obtain an APP for the planned HLP. BADCT is to be applied throughout the entire facility life cycle including design, construction, operation, and closure. In regard to the HLP settlement, Section 3.2.4.3.2 titled, "Leachate Collection/Hydrostatic Head Control" of the BADCT Manual for individual BADCT requirement states:

> *"The potential for subsidence and settlement to affect liner slope should be considered when calculating leachate collection system drainage capacity."*

Settlement of the HLP foundation due to loading, and the effect on the drainage capacity of the System that is placed upon it, is evaluated in this memo.

3.0 Methods

Foundation settlement will take place where new loading from material placement occurs during and after ore stacking. The relevant area for the analysis of foundation settlement is the HLP center solution collection channel where pipes will carry fluid downgrade and out of the HLP area. Pipe specifications were determined in the Pipe Sizing Analysis Memo (Wood 2021a) and used for the System. To determine if settlements will cause adverse flow in the channel, foundation settlement needs to be calculated at various locations along it. To calculate the one-dimensional (1D) elastic compression of the foundation following HLP regrading, the following equation was used:

$$\text{Equation 1: } S = \frac{P}{E_S} * h$$

Where S is foundation settlement, P is design load, E_S is compression modulus, and h is the thickness of the compression layer considered (i.e., fill and native soil under the System). The design load (P) is due to loading from the over-liner (P_{OL}) and the heap leach ore (P_{ORE}). Each load is the product of the thickness (t) of overlying material and the material unit weight (γ). Values for P are calculated using the following equation:

$$\text{Equation 2: } P = P_{OL} + P_{ORE} = \gamma_{OL} t_{OL} + \gamma_{ORE} t_{ORE}$$

The thickness of the compression layer (h) changes along the System as the depth of the HLP foundation and the depth to bedrock changes. The depth to bedrock was reported in the Geotechnical Site Investigation Memo (Wood 2021c) from nearby boreholes and used in this analysis. The depth of the HLP foundation was determined from the HLP grading plan compared to the existing ground depth. Figure 1 outlines the proposed System, the proposed heap leach ore stack, nearby boreholes, and a profile view that includes the existing ground, the estimated depth to bedrock, the proposed grading plan, and the proposed heap leach ore stack.

4.0 Assumptions and Inputs

The following assumptions are used for settlement calculations:

- Maximum stacking heigh over HLP above the System = 354 feet composed of
  - Over-liner (3 feet)
  - Heap Leach Ore (354 feet minus 3 feet = 351 feet)
- Trench bedding/backfilling using an over-liner
  - 1.5-inch minus rock (Wood 2021b)
  - Unit weight = 125 pounds per cubic foot (pcf) (Wood 2021b)
- Primary loading material, heap leach ore
  - Unit weight = 125 pcf (Tetra Tech 2007; Tetra Tech 2009)
- Foundation soil (or "compression layer" referred to above)
  - Dense to very dense and coarse material (Wood 2021b), or engineered from pad grading
  - Modulus E_S = 2,000 kips per square foot (ksf) = 2,000,000 pounds per square foot (psf) (Bowles, 1982; assumed lower limit for dense sand and gravel)
- Depth of alluvium and foundation material considered for settlement
  - Depth to bedrock is assumed from boreholes (Wood 2021c) with the following criteria

  - Depth to bedrock at the station nearest to a borehole is assigned the depth of bedrock from that borehole
  - Depth to bedrock is assumed to be below the existing ground
  - Depth to bedrock profile assumed to be linear between known points unless the above case is not satisfied in which case the profile is assumed to be equal to the existing ground and projected linearly to next known point

- Alluvium and foundation material are assumed to be of similar composition (Wood 2021b)

5.0 Calculations

The maximum design load (around Stationing 58+03) is comprised of the pipe backfill and the future stacking of the ore material (Equation 2):

$$Design\ load = (125\ pcf)(3ft) + (125\ pcf)(351\ ft) = 44{,}250\ psf$$

The elastic compression of 47.3 feet composed of the foundation and alluvium underneath the proposed System was calculated (Equation 1):

$$S = \frac{44{,}250\ psf}{2{,}000{,}000\ psf} * 47.3\ ft = 1.05\ ft$$

Similar calculations were completed to check settlement along the System in areas where ore load varies or decreases thus affecting the flow capacity on reference Stationing's 32+08.62, 54+72.26, 65+92.70, and 75+34.26.

6.0 Results and Interpretations

The proposed pipeline may experience up to approximately 1 foot of differential settlement at the spot of maximum loading (around Stationing 58+03).

Settlement calculations were used to evaluate the potential impact on the flow capacity of the piping System.

- Segment A: Between Stationing 65+92.70 to 75+34.26 the current piping design invert grade is mostly around 6.2 percent (%). The loading along this segment decreases from 351 feet thick to 0 feet. A minor change of grade of about 0.2% is expected. Estimated foundation settlement is not anticipated to cause local reversal flows or significant reduction of flow capacity along the proposed System as it exits the HLP.
- Segment B: Between Stationing 54+72.26 and 65+92.70 the current piping design invert grade is mostly around 5.0%. At Station 65+92.70, the depth of settlement material is about 63.6 feet, and the expected settlement is around 1.4 feet. The loading along this segment is generally consistent, and the grade is steep enough that there will be little affect to capacity.
- Segment C: Between Stationing 32+08.62 and 54+72.26 the current piping design invert grade is mostly around 2.8%. At Station 54+72.26, the depth of settlement material is about 57.4 feet, and the expected settlement is around 1.2 feet. The loading along this segment generally increases along stationing; therefore, future foundation settlement is anticipated to result in increased pipe invert grades and will lead to higher flow capacities.
- Segment D: Between Stationing 0+00 and 32+08.62 the current piping design invert grade is mostly around 5.7%. At Station 32+08.62, the depth of settlement material is about 38.6 feet, and the expected

settlement is around 4.5 inches. The loading along this segment is relatively consistent, and the grade is steep enough that there will be little affect to capacity.

- The overall current design invert grade is 4.8% (Segments A through D). At Station 0+00, the depth of settlement material is about 53.5 feet, and the expected settlement is around 7.8 inches. The overall grade after this settlement is expected to remain at 4.8%.

Based on the above, estimated foundation settlements along the System due to loading on the HLP are not expected to cause adverse impacts on the drainage of the System.

7.0 References

Arizona Department of Environmental Quality [ADEQ], 2004. Arizona Mining BADCT Guidance Manual (Publication #TB 04-01). Phoenix, Arizona.

Bowles, Joseph E., 1982. Foundation Analysis and Design. 3rd rev. ed. United States of America: McGraw-Hill Inc. 1982. 67p.

Tetra Tech, 2007. Leaching Facilities Design, prepared for Augusta Resource Corporation, by Tetra Tech, June 2007.

Tetra Tech, 2009. Rosemont Heap Leach Facility Permit Design Report. Prepared for Rosemont Copper Company, by Tetra Tech, May 2009.

Wood, 2021a. Piping Sizing Analysis Memorandum Heap Leach Facility Rosemont Copper World Project. Prepared for Rosemont Copper Company, Wood, November 2021.

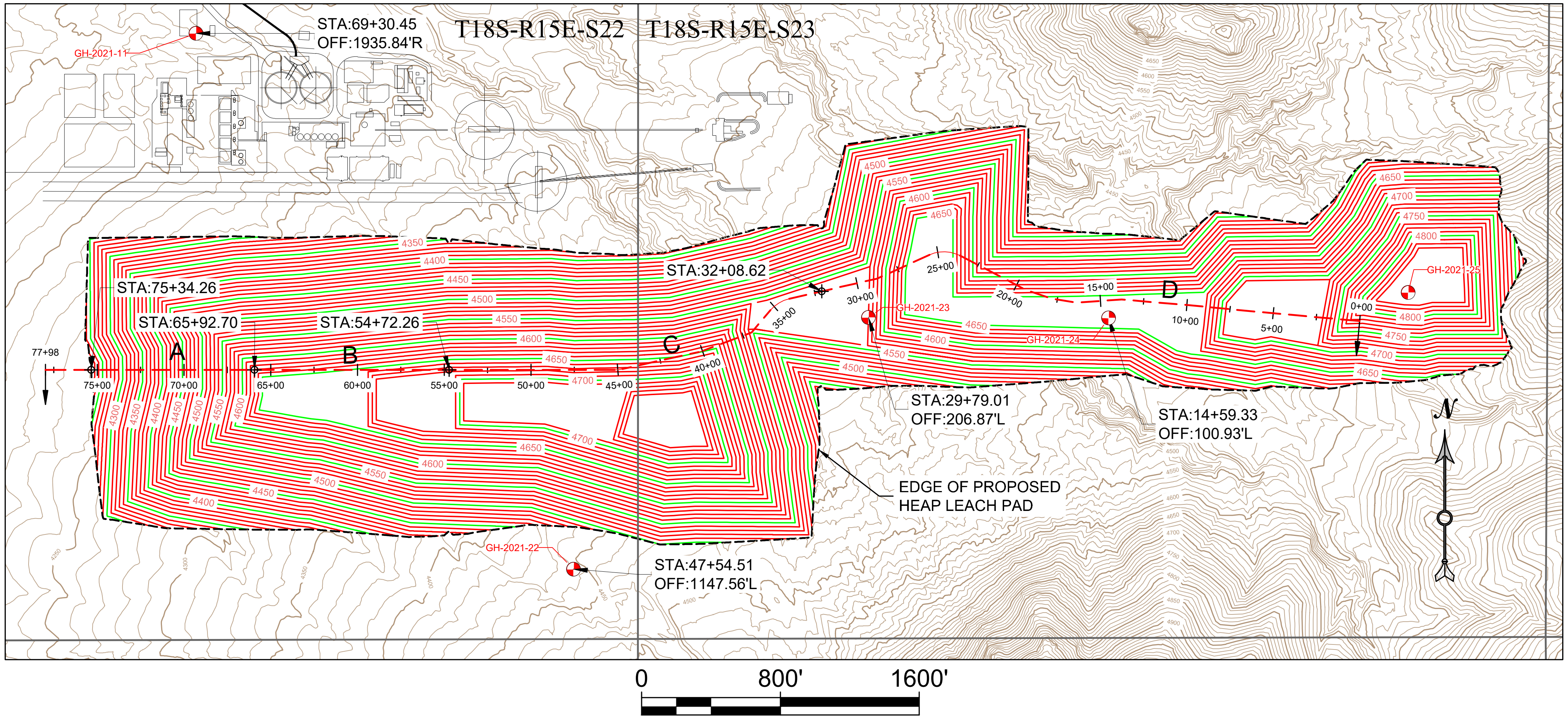
Wood, 2021b. Stability Analysis Memorandum Heap Leach Facility Rosemont Copper World Project. Prepared for Rosemont Copper Company, by Wood, December 2021.

Wood, 2021c. Geotechnical Site Investigation Memorandum, Heap Leach, Tailings and Waste Rock Facilities, Rosemont Copper World Project, prepared for Rosemont Copper Company, by Wood, December 2021.

ACRONYMS AND ABBREVIATIONS

%	%
ADEQ	Arizona Department of Environmental Quality
APP	Aquifer Protection Permit
BADCT	Best Available Demonstrated Control Technology
HLP	heap leach pad
ksf	kips per square foot
Project	Rosemont Copper World Project
pcf	pounds per cubic foot
psf	pounds per square foot
Rosemont	Rosemont Copper Company
System	primary solution collection system
Wood	Wood Environment & Infrastructure Solutions, Inc.

FIGURE



EXISTING GROUND SURFACE CONTOUR EL, FEET

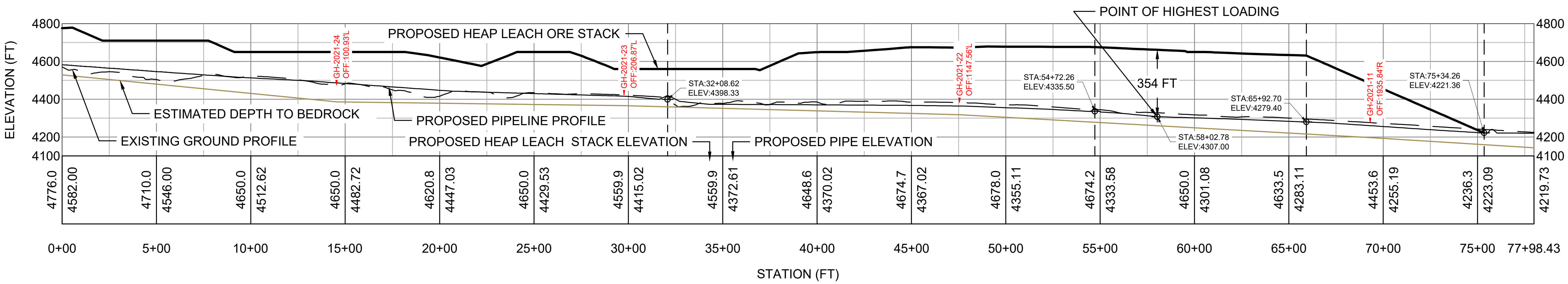
PROPOSED GROUND SURFACE CONTOUR EL, FEET

PROPOSED PRIMARY SOLUTION COLLECTION SYSTEM

GH-2021-25 BOREHOLE (WOOD 2021c)

DEPTH TO BEDROCK	
BOREHOLE ID	DEPTH TO ROCK (FT)
GH-2021-11	79
GH-2021-22	64
GH-2021-23	56
GH-2021-24	89
GH-2021-25	42

MEASUREMENTS FROM GEOTECHNICAL INVESTIGATION (WOOD, 2021c)



ROSEMONT COPPER WORLD PROJECT

PROPOSED PRIMARY SOLUTION COLLECTION SYSTEM WITH HEAP LEACH FACILITY AND NEARBY BOREHOLES

wood.

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Figure: 1

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